MEASUREMENTS OF NON-AXISYMMETRIC COIL-RELATED ERROR FIELDS IN DIII–D*

J.L. Luxon,[1] M.J. Schaffer,[1] G.L. Jackson,[1] J.A. Leuer,[1] A. Nagy,[2] J.T. Scoville,[1] E.J. Strait[1]

[1]General Atomics, P.O. Box 85608, San Diego, California 92186-5608
[2]Princeton Plasma Physics Laboratory, P.O. Box 451, Princeton, New Jersey 08543-0451

Non-axisymmetric (error) fields in tokamaks lead to a number of instabilities including so-called locked modes [1] and resistive wall modes (RWMs) [2]. They can also cause errors in magnetic measurements made by point probes near the plasma edge and measurements made by magnetic field sensitive diagnostics also they violate the assumption of axisymmetry in the analysis of data. Most notably, the sources of these error fields include shifts and tilts in the coil positions from ideal symmetry, coil leads, and nearby ferromagnetic materials magnetized by the coils. New measurements have been made of the n=1 (and n=2) coil-related field errors in the DIII–D plasma chamber using a set of 24 probes measuring B_R,B_Θ, and B_Z at 8 locations equally spaced on a ring at R=1.64 m near the plasma major radius. This apparatus is similar to the one described in earlier measurements [3], but a number of improvements were made in the apparatus and technique to improve the accuracy of the measurements. These include: collecting a complete set of 8 data points for each field component, specializing to $n \geq 1$ by using one probe of each field component as reference and subtracting the others from it, realigning the apparatus in situ, making measurements at three different elevations (–0.75 m, 0, and +0.75 m) inside of the plasma chamber, and rotating the apparatus through a large toroidal angle (65°) to identify systematic errors associated with the probes. During preparations for these measurements, a previously unrecognized large iron structure near the top of the machine, capable of causing substantial error fields (and present during the earlier measurements), was identified and removed.

Preliminary results of the measurements are that the centers of the poloidal field coils lie within a circle in the horizontal plane of radius 8 mm and are tilted from vertical by <0.2°. Both the center of this circle and the vacuum vessel are displaced from the center of the toroidal field by ~5 mm. The single largest displacement of a poloidal field coil from the axis of the toroidal field is 12 mm. The aggregate field errors of the poloidal field coils are about half as large as previously reported [3]. No new error field contributions associated with the toroid field coil were identified at the level of less than ±10 G (not previously reported). Non-linear effects due to coils operating together (e.g. the toroidal field coil distorting in the presence of a poloidal field) were not significant. These measurements failed to confirm the presence of an unrecognized substantial error field deduced from locked mode [1] and RWM [2] measurements. The difficulties of making these measurements in existing and new devices and potential sources of error including iron structures too small to affect the plasma will be discussed.

[1] Buttery, R.J., *et al* Nucl. Fusion **39,** 1827 (1999); Scoville, J.T., and R. J. LaHaye, "Multi-Mode Error Field Correction in the DIII–D Tokamak," to be submitted to Nuclear Fusion; see also ITER Physics Basis Editors, Nucl. Fus. **29** (1999) 2289.
[2] Garafalo, A.M., *et al*, "Sustained Stabilization of the Resistive Wall Mode by Plasma Rotation in the DIII–D Tokamak," submitted to Phys. Rev. Lett.
[3] LaHaye, R. J., Scoville, J.T., Rev. Sci. Instrum. **62** (1991) 2146.

*Work supported by U.S. Department of Energy under Contract No. DE-AC03-99ER54463.

D or F